PANGASIUS BEDADO ROBERTS, 1999: A JUNIOR SYNONYM OF *PANGASIUS DJAMBAL* BLEEKER, 1846 (SILURIFORMES, PANGASIIDAE)

by

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ABSTRACT. - The validities of two nominal pangasiid catfish species, *Pangasius djambal* and *P. bedado* were examined based on morphometric, meristic, and biological characters. Metric data were analysed using principal component analysis. Based on our results, we consider *P. bedado* as a junior synonym of *P. djambal*.

RÉSUMÉ. - *Pangasius bedado* Roberts, 1999 : un synonyme junior de *Pangasius djambal* Bleeker, 1846 (Siluriformes, Pangasiidae).

La validité de deux espèces nominales de poissons chats Pangasiidae, *Pangasius djambal* et *P. bedado*, a été examinée sur la base de caractères morphométriques, méristiques et biologiques. Une analyse en composantes principales a été appliquée sur les données métriques. Nos résultats nous amènent à considérer *P. bedado* comme synonyme junior de *P. djambal*.

Key words. - Pangasiidae - *Pangasius djambal* - *Pangasius bedado* - Biometrics - Synonymy.

Pangasiid catfishes are characterized by a laterally compressed body, the presence of two pairs of barbels, the presence of an adipose fin, dorsal fin with two spines (Teugels, 1996), and anal fin 1/5 to 1/3 of standard length (Gustiano, 2003). They occur in freshwater in Southern and Southeast Asia. Based on our osteological observations, this family forms a monophyletic group diagnosed by: the os parieto-supraoccipitale processus robust, bifurcated with ridge at the tip; medial posterior process of parurohyale bifid and its lateral process wing shape. The additional character supporting this family is anterior mesethmoid notched (Gustiano, 2003).

Since 1996, numerous sampling campaigns carried out all over Southeast Asia provided detailed information on the geographical distribution of pangasiid species. Legendre *et al*. (2000) recorded *P. djambal* Bleeker, 1846 from Java (Brantas and Solo Rivers) and Kalimantan (Barito, Mendawai, and Kahayan Rivers). The species also occurs in most major drainages of Sumatra, where it was observed in the Musi, Batang Hari, and Indragiri Rivers. Previous workers considered *P. djambal* absent from Sumatra (Vaas *et al*., 1953; Kottelat *et al*., 1993). Although the type locality of *P. djambal* is Batavia (former name of Jakarta), this species seems no longer extant in all rivers of west Java. Tan and Ng (2000) reported *P. djambal* from the Indragiri River; however, they hypothesized that it may have been introduced.

Roberts and Vidthayanon (1991) gave a description of *P. djambal*. They distinguished it from other *Pangasius* species by the following characters: rounded or somewhat truncate (never pointed) snout, palatal teeth with two palatine patches and a moderately large median vomerine patch (but vomerine patch usually clearly divided into two in juveniles), at least some specimens with a marked color pattern on body and fins, including two stripes on caudal lobes.

In 1999, *Pangasius bedado* was originally described by Roberts based on two specimens from the Musi River in South Sumatra. *Pangasius bedado* differs from all other species of Pangasiidae from Sumatra in having dorsal fin without filamentous projection, total anal fin rays 30-31, head length no more than 5 times in standard length, caudal fin with white distal margin. In his discussion, Roberts (1999) did not compare *P. bedado* with *P. djambal,* which he hypothesized to be absent from Sumatra. As part of an ongoing study on the biodiversity and aquaculture of Southeast Asian catfishes, this paper reviews the validity of *P. djambal* and *P. bedado* as distinct species.

MATERIALS AND METHODS

Nine hundred and ninety nine *Pangasius* specimens collected during the "Catfish Asia" project, Institut de Recherches pour le Développement (IRD) formed the core of the material examined in the present study. Specimens

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were obtained from Bangladesh, Vietnam, Cambodia, Thailand, Malaysia and Indonesia. Additional material including types of 41 previously described nominal species of *Pangasius* housed in various museum was also examined. The complete list of comparative material can be requested at the corresponding author's address. The following type and specimens of *P. bedado* and *P. djambal* housed in Museum Zoologicum Bogoriense (MZB), Kasetsart University Museum of Fisheries (KUMF), RMNH (Rijskmuseum van Naturlijke Historie), and IRD (Institut de Recherches pour le Développement) were examined:

Pangasius bedado. - MZB 2598, 375 mm SL, Palembang, Musi River, Sumatra; holotype. - KUMF 3142, 410 mm SL, Jambi, Batang Hari River, Sumatra; paratype.

Pangasius djambal. - RMNH 6854, 374 mm SL, Batavia, Java, neotype (designated by Roberts and Vidthayanon, 1991). - RMNH 8069, 214 mm SL, Bleeker's collection, Batavia, Java. - 6 spms: RMNH 31192, 112-120 mm SL, Bleeker's collection, Java. - 3 spms: IRD 66-68, 327-424 mm SL, Palembang, Musi River, Sumatra. - 18 spms: IRD (97, 101-111, 153-155, 157-160), 271-358 mm SL, Jambi, Batang Hari River, Sumatra. - 21 spms: IRD (503, 506-516, 520-528a), 211-283 mm SL, Jombang, Brantas River, Java. - IRD 531, 275 mm SL, Kepu, Solo River, Java. - IRD 560, 528 mm SL, Muara Teweh, Barito river, Kalimantan. - 21 spms: IRD (R38, 44-45, 47-49, 54-63), 279-470 mm SL, Jambi, Batang Hari River, Sumatra. - 6 spms: IRD (BJM9, 19, 15, 52, 55-58), 527-623 mm SL, Banjarmasin, Barito River, Kalimantan. - 3 spms: IRD (BTK 8-10), Buntok, Barito River, Kalimantan. - 10 spms: IRD (1338-1343, 1345-1348), 236-314 mm SL, Rengat, Indragiri River, Sumatra. - IRD RE53, 254 mm SL, Jambi, Batang Hari, Sumatra. - 23 spms: IRD (RE1-22, 24), 142-273 mm SL, Rengat, Indragiri River, Sumatra.

Thirty three point to point measurements were taken using dial callipers, following Pouyaud *et al*. (1999). Two other measurements were added: anterior width of snout, taken between the anterior nostrils; posterior width of snout, taken between the posterior nostrils. The following abbreviations are used: SL, standard length, HL, head length, ED, eye diameter, and DSI, distance snout-isthmus. Body length was measured using a graduated ruler of one meter. Five counts were taken: total number of gill rakers on the first branchial arch, number of dorsal-, anal-, pectoral-, and pelvic-fin rays. Morphological observations include the shape of the swimbladder and the shape of palatine and vomerine tooth patches.

Metric data were subjected to principal component analysis (PCA) (Bookstein *et al*., 1985) using the CSS Statistica package (StatSoft, Inc.), version 4.5 in order to define structuring characters. For this purpose, measurements were log-transformed in order to minimise the effect of non-normality before the PCA was run on the covariance matrix; the first factor, considered as the size-factor I was not considered, in order to minimize the effect of size differences between the samples. Missing data were casewise deleted.

RESULTS AND DISCUSSION

We first compared *P. bedado* and *P. djambal* with all taxa arranged as genera and subgenera in Pangasiidae and recognised by Roberts and Vidthayanon (1991).

Pangasius djambal and *P. bedado* differ from the species of *Helicophagus* Bleeker, 1858 (*H. typus* Bleeker, 1858; *H waandersii* Bleeker, 1858; *H. leptorhynchus* Ng & Kottelat, 2000) by the robust anterior part of snout length (29.3-36.6% HL *vs* 11.2-16.5% HL), posterior nostrils close behind anterior ones and above imaginary line from anterior nostril and orbit (versus posterior nostrils are in between anterior ones and orbit), long and slender premaxillary toothplate (versus short and large premaxillary toothplate).

Pangasius djambal and *P. bedado* differ from *Pangasius* (*Neopangasius*) Popta, 1904 [*P. humeralis* Roberts, 1989; *P. lithosoma* Roberts, 1989; *P. nieuwenhuisii* (Popta, 1904); *P. kinabatangensis* Roberts & Vidthayanon, 1991] by the presence of clearly marked palatine toothplates.

Pangasius djambal and *P. bedado* differ from *Pangasius* (*Pangasianodon*) Chevey, 1930 [(*P. hypophthalmus* Sauvage, 1878; *P. gigas* (Chevey, 1930)] by six pelvic fin rays (*vs*. 8-9).

Pangasius djambal and *P. bedado* differ from *Pangasius* (*Pteropangasius*) Fowler, 1937 (*P. pleurotaenia* Sauvage, 1878). The latter is characterised by a well developed abdominal keel extending from vent to base of pectoral fins (*vs*. poorly developed).

We therefore consider *P. djambal* and *P. bedado* as belonging to the fourth subgenus recognised by Roberts and Vidthayanon (1991), *Pangasius* (*Pangasius*) Valenciennes, 1840 for which no proper diagnosis was given by these authors. In *Pangasius* (*Pangasius*), *P. djambal* and *P. bedado* differ from *P. micronemus* Bleeker, 1847 which has a minute maxillary barbel length (84.2-191.2% ED *vs* 233.7-531.3% ED).

Pangasius djambal and *P. bedado* differ from *P. macronema* Bleeker, 1851 by a smaller eye diameter (10.1-21.3% HL *vs* 21.9-45% HL), shorter mandibulary barbel length (25.3-52.4% HL *vs* 76.8-176.5% HL) and shorter maxillary barbel length (31.8-66.2% HL *vs* 100.5-203.9% HL).

Pangasius djambal and *P. bedado* differ from *P. polyuranodon* Bleeker, 1852; *P. elongatus* Pouyaud *et al*., 2003; and *P. mahakamensis* Pouyaud *et al*., 2003 by a longer predorsal length (35.5-41.9% SL *vs* less than 34% SL).

Pangasius djambal and *P. bedado* differ from *P. sanitwongsei* Smith, 1931 and *P. larnaudii* Bocourt 1866. The latter two species have filamentous fin rays. The humeral spot in *P. larnaudii* is another character that enables to dif-

ferentiate it from *P. djambal* and *P. bedado*. Narrower width of mouth is another character to distinguish *P. djambal* and *P. bedado* from *P. sanitwongsei* (37.1-49.1% HL *vs* 50.1-57.9% HL).

Pangasius djambal and *P. bedado* differ from *P. krempfi* Fang & Chaux, 1949 by a unique combination of the following characters: predorsal length (35.5-41.9% SL *vs* 31.8-35.3% SL), snout length (34.6-49.9% HL *vs* 45.5-52.4% HL), posterior part of snout width (33-46.2% HL *vs* 42.2-47.9% HL).

Pangasius djambal and *P. bedado* differ from *P. rheophilus* Pouyaud & Teugels, 2000 by a unique combination of the following characters: head length (21.8-27.1% SL *vs* 19.6-23.2% SL), head width (13.4-19.4% SL *vs* 11.2-14.2% SL), body width (16.8-21.4% SL *vs* 14.9-17% SL).

Pangasius djambal and *P. bedado* differ from *P. bocourti* Sauvage, 1880 only by the number of gill rakers on the first branchial arch (27-39 *vs* 35-47). But there is no overlap.

Pangasius djambal and *P. bedado* differ from *P. conchophilus* Roberts & Vidthayanon, 1991, *P. myanmar* Roberts & Vidthayanon, 1991 and *P. pangasius* (Hamilton, 1822) by a higher gill raker number on the first branchial arch, 27-39 (*vs* less than 27).

Pangasius djambal and *P. bedado* differ from *P. mekongensis* Gustiano *et al*., 2003 and *P. sabahensis* Gustiano *et al*., 2003 by a longer distance snout-isthmus (103.8-133.3% SNL *vs* 88.2-102.8% DSI).

Finally, PCA analysis on *P. djambal* and *P. bedado* and two species which often occur in the same basin [*P. nasutus* (Bleeker, 1862) and *P. kunyit* Pouyaud *et al*., 1999)] demonstrated that the combination of PCII against PCIII

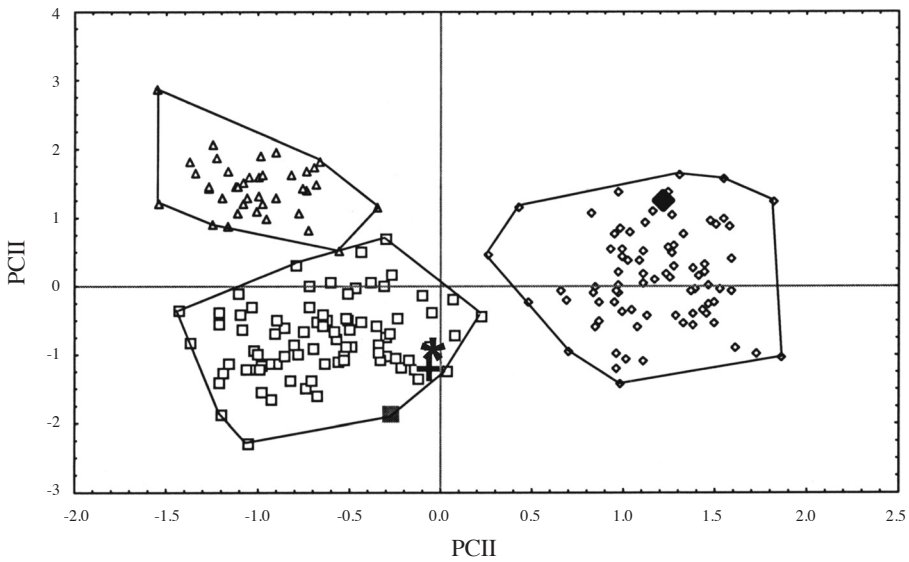

Figure 1. - Plot of the second principal component (PCII) and the third principal component (PCIII) derived from a principal component analysis of 29 log-transformed metric variables taken on 272 *Pangasius* specimens. (*) Holotype of *Pangasius bedado*; (+) paratype of *P. bedado*; (■) neotype of *P. djambal*; (□) specimens of *P. djambal*; (◆) holotype of *P. nasutus*; (◇) specimens of *P. nasutus*; (△) specimens of *P. kunyit*.

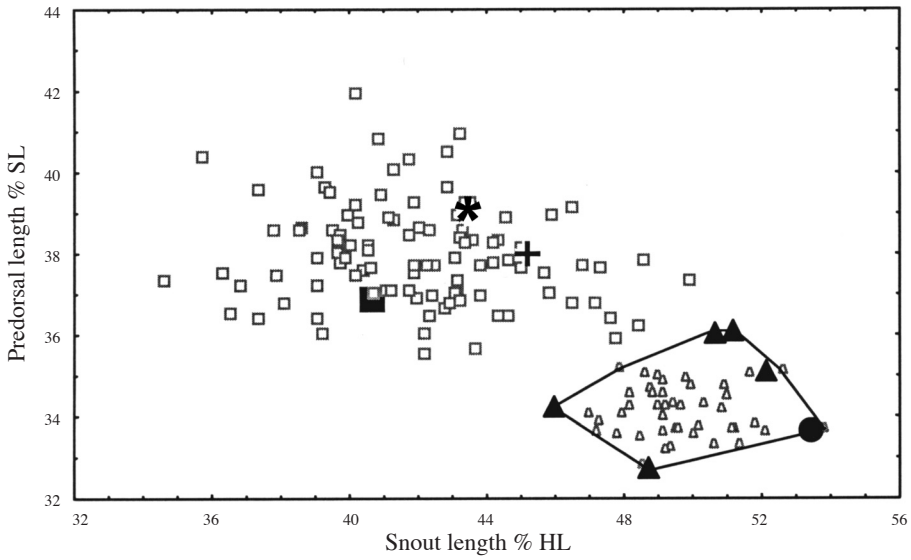

Figure 2. - Scatter plot showing the snout length (% HL) in function of predorsal length (% SL) for some *Pangasius* species from Indonesia. (*) Holotype of *Pangasius bedado*; (+) paratype of *P. bedado*; (■) neotype of *P. djambal*; (□) specimens of *P. djambal*; (●) holotype of *P. kunyit*; (▲) paratypes of *P. kunyit*; (△) specimens of *P. kunyit*.

Table I. - Factor score coefficients of the second and third principal components for the principal component analysis for 272 specimens of *Pangasius djambal*, *P. kunyit* and *P. nasutus* using 29 log-transformed metric variables.

Characters	PCII	PCIII
Log head length	-0.079400	0.079221
Log snout length	0.047219	-0.086179
Log anterior width of snout	-0.004809	-0.092567
Log posterior width of snout	0.056611	-0.021453
Log head depth	0.093844	0.000826
Log head width	0.132983	-0.022275
Log predorsal length	-0.070160	0.153337
Log caudal peduncle length	0.074888	0.126654
Log caudal peduncle depth	0.186978	0.123196
Log anal fin height	-0.052814	-0.017247
Log anal fin length	0.132239	0.102560
Log adipose fin height	0.217947	-0.050067
Log adipose fin width	0.336828	-0.041073
Log eye diameter	0.584534	0.120291
Log width of mouth	-0.060764	-0.143510
Log lower jaw length	-0.053265	-0.224794
Log interorbital distance	0.028620	-0.034789
Log distance snout to isthmus	-0.092223	0.145102
Log postopercular length	-0.295483	0.187666
Log maxillary barbel length	0.064446	-0.160305
Log mandibular barbel length	-0.086199	-0.113645
Log body width	-0.016571	0.048977
Log prepectoral length	-0.081738	0.043901
Log prepelvic length	-0.012001	0.114567
Log vomerine width	-0.178614	-0.082133
Log vomerine length	-0.358994	0.169601
Log palatine length	-0.227159	-0.161607
Log palatine width	-0.027457	-0.264288
Log dorsal spine width	-0.197198	0.051192

enables to distinguish the species into three groups (Fig. 1). The first group including *P. djambal* and also the types of *P. bedado*, is mostly located in the negative sector of PCII and the negative sector of PCIII. The second group including *P. kunyit* is entirely situated on the negative sector of PCII and on the positive sector of PCIII. The third group including *P. nasutus*, is entirely located on the positive sector of PCII. Factor score coefficients for this analysis are given in table I.

PCII which separates *P. nasutus* from the other species is merely defined by the eye diameter, vomerine toothplate length, postocular length, and adipose fin width. PCIII which separates *P. djambal* from *P. kunyit* is merely defined by palatine toothplate width, lower jaw length, predorsal length, maxillary barbel length, and distance snouth-isthmus. In figure 2, the snout length is plotted against the predorsal length, *P. kunyit* can be distinguished from *P. bedado* and *P. djambal* by relatively shorter predorsal length and longer snout length.

Metrics and meristics for the type of *P. bedado* and *P. djambal* are given in table II. No significant differences between both can be indicated.

Morphologically, *P. djambal* and *P. bedado* are distinguished from all other species by the unique combination of the following characters: somewhat elongated body with a long predorsal length (35.5-41.9% SL), body width large (16.8-21.4% SL), moderate eye diameter (10.1-21.3% HL), snout length superior to the distance from snout to isthmus (103.8-133.3%), number of gill rakers on the first branchial arch 27-39.

Pangasius djambal has head and body brownish or green dorsally and laterally, white ventrally, with dark midlateral and abdominal bands. Our observations on the types of *P. bedado* showed a similar coloration. The caudal fin varies from pale grey to dark in *P. djambal*; some specimens have a white margin as reported by Roberts (1999) for *P. bedado*.

The swimbladders of 34 specimens of *P. djambal* were examined. Twenty specimens from Java (Brantas and Solo Rivers) showed a two-chambered bladder with a clearly marked small tip at the end of the posterior chamber. In twelve specimens from the Batang Hari River (Sumatra) two chambers are present but with the tip of the posterior chamber very small to nearly absent. Finally in two specimens from the Musi River, the third chamber is present. The latter corresponds to the condition reported in *P. bedado* by Roberts (1999). The variation of swimbladder is probably due to the size differences. All specimens from Java and Batang Hari River used for swimbladder observation are less than 290 mm SL, while the specimens from the Musi River are more than 370 mm SL.

The gut content of 6 specimens of *P. djambal* was examined. Results showed that one specimen only contained gastropods; three specimens contained gastropods and clams; one specimen contained gastropods, clams and small fish bones; and one specimen contained gastropods and seeds. Based on this observation, *P. djambal* is molluscivorous with tendency to opportunism. The gut content of one specimens of *P. bedado* contained shelled molluscs (full of shelled molluscs, mainly clams but also some small snails) (Roberts, 1999).

As no discriminant characters have been observed between *P. djambal* and *P. bedado*, we conclude that they are conspecific and *P. bedado* is considered as the junior synonym of *P. djambal*.

Table II. - Metric and meristic variables for *Pangasius djambal* and *P. bedado*.

Characters	*P. djambal*						*P. bedado*	
	Neotype	N	Mean	Min	Max	SD	Holotype	Paratype
SL (mm)	374	106	-	142	635	-	365	400
In % standard length								
Head length	22.2	106	24.1	21.8	27.1	0.94	24.6	22.2
Head depth	10.7	106	11.8	9.0	13.6	0.94	12.0	11.9
Head width	14.5	106	16.3	13.4	19.4	1.27	18.2	16.3
Predorsal length	36.9	106	38.0	35.5	41.9	1.24	39.0	38.1
Caudal peduncle length	17.9	106	16.3	14.4	18.6	0.91	16.0	16.8
Caudal peduncle depth	7.5	106	8.1	6.7	9.2	0.51	8.5	8.5
Pectoral spine length	17.6	91	18.7	12.5	24.2	2.12	19.8	18.1
Pectoral fin length	20.3	67	17.3	11.9	21.3	2.03	22.1	19.7
Dorsal spine length	18.4	89	21.3	15.1	26.7	2.18	18.0	19.6
Dorsal fin length	-	67	18.1	10.7	24.7	2.85	22.7	22.9
Pelvic fin length	12.2	104	12.2	9.7	19.5	1.27	14.0	13.3
Anal fin height	12.7	102	13.1	9.8	15.6	1.18	13.6	12.8
Anal fin length	28.4	106	27.2	23.8	29.9	1.32	27.4	28.2
Adipose fin height	4.1	106	4.4	3.4	5.9	0.39	4.4	4.7
Adipose fin width	1.5	106	1.9	1.1	2.9	0.32	2.2	2.0
Body width	17.5	104	19.1	16.8	21.4	1.08	20.8	19.7
Prepectoral length	20.6	105	21.1	18.4	23.3	1.08	22.5	18.9
Prepelvic length	45.8	105	47.7	43.6	52.0	1.78	48.5	46.5
In % head length								
Snout length	40.6	101	42.0	34.6	49.9	2.99	43.5	45.2
Anterior snout width	31.6	105	32.1	29.3	36.6	1.46	32.9	35.7
Posterior snout width	41.3	105	39.7	33.0	46.2	2.16	39.6	42.0
Eye diameter	19.4	105	15.4	10.1	21.3	2.39	12.9	13.2
Mouth width	43.3	106	43.4	37.1	49.1	2.42	46.7	46.7
Lower jaw length	27.0	106	25.6	19.3	31.7	2.19	25.0	27.1
Interorbital distance	12.1	105	14.0	11.6	16.9	1.14	13.4	14.5
Snout to isthmus distance	47.3	100	48.9	43.6	56.4	2.97	50.4	52.6
Postocular length	36.1	104	34.9	27.8	42.7	3.00	41.8	39.3
Maxillary barbel length	51.3	100	55.7	31.8	66.2	6.25	54.4	62.9
Mandibulary barbel length	34.7	101	37.2	25.3	52.4	6.39	37.2	36.8
Vomerine tooth width	20.5	106	21.8	16.6	27.4	2.26	25.5	27.9
Vomerine tooth length	10.2	106	7.0	3.8	11.5	1.56	11.5	10.6
Palatine tooth length	17.8	106	13.3	8.3	16.3	1.53	17.1	17.8
Palatine tooth width	4.7	105	3.9	2.3	5.3	0.61	4.8	4.9
Dorsal spine width	8.7	103	7.4	5.8	9.5	0.70	7.4	8.3
Counts								
Gill rakers	32	102	-	27	39	-	38	30
Dorsal rays	7	104	-	6	8	-	7	7
Pectoral rays	13	105	-	9	13	-	12	12
Pelvic rays	6	106	-	6	7	-	6	6
Anal rays	32	106	-	27	35	-	32	30

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